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Temporal and spatial variability of soil CO_2 and its isotopic signature (δ13C) in a pine forest stand

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Soil respiration is one of the most significant carbon fluxes in terrestrial ecosystems. Since different sources of soil respiration might respond differently to climate change it is necessary to separate underlying processes. Several methods have been suggested to separate root respiration and heterotrophic respiration in soils. The most promising approach is based on isotopic signature of CO_2 (δ13C).
We measured the temporal variability as well as vertical and horizontal gradients of soil CO_2 in a pine forest ecosystem (ICP Forests plot DE1203) over the entire vegetation period of 2018. Further-more, the isotopic signature of CO_2 (δ13C) was detected in order to evaluate the potential for separating autotrophic and heterotrophic shares of soil respiration. Soil gas samples were collected every 80 minutes using gas permeable polypropylene gas probes and measured using Cavity Ring Down Spectroscopy. The forest ecosystem is dominated by mature Scots pine trees (Pinus sylvestris) and a dense ground vegetation of blueberry (Vaccinium myrtillus L.) and moss (Scleropodium purum (Hedw.) Limpr.]). Soil type is Haplic Podsol from medium-coarse sand.
Results provided clear correlations of CO_2 concentrations and its δ13C signature with meteorological conditions and spatial gradients. CO_2 concentrations increased following rain events, but δ13C val-ues decreased. Diel variation showed minimum CO_2 concentrations with maximum δ13C values at noontime. Amplitudes of temporal effects decreased and were postponed with increasing soil depth. CO_2 concentration increased with soil depth, but δ13C values decreased. In a spatial gradient from in between trunk area towards a single trunk CO_2 increased, but δ13C values decreased, which might be caused by varying root density.
It is a challenge to clarify these interactions - our approach delivers a basis already proven to reveal temporal and spatial variability of soil CO_2 and its isotopic signature under site conditions.